

## **A Note on Organizational Leadership as Problem Solving**

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# A NOTE ON ORGANIZATIONAL LEADERSHIP AS PROBLEM SOLVING

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# A NOTE ON ORGANIZATIONAL LEADERSHIP AS PROBLEM SOLVING

## Introduction

### A Problem-Solving Model

Functional and systems approaches underlie much of the research on requirements for leadership performance in military organizations. One body of this research (Mumford, 1986a; Mumford, 1986b; Mumford, Yarkin-Levin, Korotkin, Wallis, Marshall-Mies, 1986) emerged as a model of executive, organizational leadership (Fleishman, Mumford, Zaccaro, Levin, Korotkin, & Hein, 1991; Mumford & Connelly, 1991; Mumford, Zaccaro, Harding, Fleishman, & Reiter-Palmon, 1993). This model defined organizational leadership as discretionary problem solving in ill-defined social settings. The model further specified a taxonomy of the leader behaviors required for effective problem solving. The taxonomy consisted of four broad dimensions of leader problem-solving behavior: information search and structuring, information use in problem solving, managing personnel resources, and managing material resources. Expert judgments were obtained to decompose the four superordinate dimensions into more discrete descriptions (or representations) of the cognitive abilities, knowledge, temperament attributes (motivation and personality), and complex problem-solving skills involved in effective problem-solving behavior.

Shortly after this model of leadership problem solving had been advanced, its construct validity was tested with a sample of slightly over 1800 U.S. Army commissioned officers, ranging in rank from second lieutenant to full colonel. All officers were then attending a basic or more advanced course as part of the U.S. Army's system of institutional education and training. In this test, the predictor measures represented the requirements (cognitive abilities, temperament attributes, etc.) set forth in the problem-solving model. The criteria generally consisted of self-reported indicators of career achievement or of the quality of written responses to paper-and-pencil, problem-solving exercises.

As of the present report, results of the construct validation have not been fully reported. Recent presentation (Management Research Institute, 1995) has suggested that findings generally supported the overall hypothesis of the model. This hypothesis is that the cognitive and temperament variables set forth in the model explain variance in the career achievement and problem-solving effectiveness of officers. A further expectation from the model is that problem-solving skills become increasingly

important with the increases in decision discretion across organizational levels. From the available presentations, the support for this latter suggestion was less certain.

### Replication and Extension of Original Test

#### Rationale

The original test of construct validity suggested that the problem-solving model of organizational leadership and its measurement have potential for use in the development of Army leaders. Those presentations also made clear the need for further research on the generalizability of initial findings before decisions are made about use of the model and its measures.

While the identification of leadership with problem solving was not totally new, the problem-solving model of organizational leadership provided a new construction of the cognitive capabilities and temperament attributes necessary for effective leadership. Many of the measures of the hypothesized constructs were also new and created for the original test. As with any advance in theory or measurement, repeated testing of the model was needed to determine the reliability of the original findings.

In addition, it seemed important to test the model with leaders who are actually involved in organizational problem solving. That is, the original test used students. As such, the students were not at the time actually involved in the solution of organizational problems as much as they were engaged in learning how to become good leaders. Given the original sample, two general types of criteria were used. One type represented career achievements (e.g., self reports of recommendations for command, receipt of awards, recommendations for early promotion). The second represented performance on paper-and-pencil, problem-solving exercises.

Even though useful, such criteria do not yield clear interpretations about the contributions of individual-difference variables to performance across levels of organizational leadership. The likelihood of receiving certain achievements, for example, varies with time. When used to compare individuals across levels of career advancement, a measure of achievement could have reflected opportunity as much as the quality of past performance. Differences on paper-and-pencil exercises are also open to competing interpretations. As found in other educational settings, the use of unstructured written exercises as an instructional method likely increases from the introductory Army courses (e.g., Officer Basic Course) to the more advanced courses (e.g., Command and General Staff College or Senior Staff College). As such, differences by leadership level could have



represented the practice which the respective courses had provided on written, open-ended exercises like those used as criteria.

### Objectives

The overall purpose of the research reported here was to provide additional evidence on the problem-solving model of organizational leadership. As such, the research tested the hypothesis that the cognitive and temperament attributes set forth in the model explain variance in the career achievement and the problem-solving effectiveness of officers. This research provided opportunity for only a partial replication of the original test due to the research sample. That is, the sample for this research was more junior in level of leadership than was the original sample. This limitation was somewhat balanced by use of officers in the chains of command within a sample of line units. This sample permitted extension of the criterion set to the observed and expected quality of the behavior of leaders within the context of organizational operation.

### Research Approach

This research tested the problem-solving model on officers filling leadership positions in the chains of command of Army battalions. Although there was some variation in chain-of-command positions, those positions were typically organized according to a hierarchy like the following, in ascending order: platoon leader, company commander, and battalion commander. Accordingly, within the sampled battalions, the officers serving as platoon leaders, company commanders, and battalion commanders responded to measures of the cognitive and temperament attributes and provided self reports of their achievement. The leadership of these officers was rated by individuals who were superior to and subordinate to them in the battalion chain of command.

### Predictors

The selection of cognitive and temperament instruments built on the original test. During the selection, analyses of the original data were still ongoing. To enable cumulative evidence, the original researchers provided advice as to which measures appeared most promising for replication. Advice on promise was driven by several general consideration. One consideration was the likelihood that an instrument actually differentiated leaders at the levels sampled for this replication. This was assessed on the basis of the available findings from the original research. A second concern focused on the instruments as a set and the extent to which the set covered all categories of variables in model. Another consideration was the time required for

completion of the instruments. Administration requirements needed to fit reasonably with the time likely available for research participation. These considerations resulted in measurement of the cognitive and temperament variables presented in Table 1. Table 1 also shows the overlap between the predictors in the original test and the predictors in this replication.

### Criteria

Like the original test, this replication used indicators of achievement as criteria. Two self-report measures were used. One was rank. The other consisted of the awards which an officer reported as having received throughout his/her career. At the outset, it was expected that these two indicators are correlated.

The model under investigation characterizes leadership as organizational problem solving and, thereby, hypothesizes that problem solving, as measured by the model, is related to assessments of the effectiveness of leadership in an organizational setting. This replication used two measures of leadership performance as criteria. One consisted of ratings by subordinates of an officer's transformational leadership style, as measured by the Multifactor Leadership Questionnaire (Bass & Avolio, 1991). Bass (1985) argued that compared to transactional behaviors, transformational leadership enhances the performance of organizational members. Bass and his colleagues (e.g., Lau, Atwater, Avolio, & Bass, 1993) have also demonstrated that transformational leadership is associated with leadership and managerial effectiveness. A second measure was a variant of supervisor ratings. That is, an officer's immediate superior rated the target officer's "competence" to engage in types of missions which, according to military doctrine (Department of the Army, 1993), units could be called upon to perform. This replication, thus, tested the expectations that the components of problem-solving behavior support (and are positively associated with) the performance of an effective leadership style and assessments of competence to perform organizational missions.

### Analysis

Recent presentation of the original test (Management Research Institute, 1995) described the psychometric properties of the measures and compared officers both within and between ranks. Regression analyses identified a model of the cognitive and temperament variables which parsimoniously and best accounted for variance in career achievement. The original data-analysis methods were followed in this replication, to include regression analyses to validate the best-fit model derived in the original presentation.

Table 1.  
Crosswalk of original and replication measures/variables

<u>COGNITIVE ABILITIES</u>	
Standard Measures	
<i>Verbal reasoning</i>	
Creative thinking capacities	
Writing skill	
Creative writing	
New Measures	
<i>Oral expression</i>	
<i>Reading orientation</i>	
<i>Problem sensitivity</i>	
<u>MOTIVATION/VALUES</u>	
Standard Measures	
Achievement	
Dominance	
Responsibility	
New Measures	
<i>Social recognition</i>	
<i>Social commitment</i>	
<i>Need for affiliation</i>	
<i>Social alienation</i>	
<i>Need for approval</i>	
<u>PERSONALITY</u>	
Standard Measures	
Extroversion	
Sensing/intuiting	
Thinking/feeling	
Judging/perceiving	
Openness	
Ego resiliency	
New Measures	
<i>Self discipline</i>	
<i>Rigidity</i>	
<i>Locus of control</i>	
<i>Ego resiliency</i>	
<i>Competitiveness</i>	
<i>Environmental engagement</i>	
<u>KNOWLEDGE</u>	
New Measures	
Leadership expertise	
Leadership problem solving	
<u>SOCIAL JUDGMENT SKILLS</u>	
New Measures	
<i>Social judgment</i>	
<i>Self reflectivity</i>	
<i>Insightfulness</i>	
<i>Good judgment</i>	
<i>Systems perceptiveness</i>	
<u>PROBLEM-SOLVING SKILLS</u>	
New Measures	
<i>Problem-construction</i>	
<i>Problem-solving component skills</i>	
<i>Creative problem solving</i>	
<u>PRACTICAL INTELLIGENCE</u>	
New Measures	
<i>Troubleshooting</i>	
<i>Planning under ambiguity</i>	
<i>Monitoring</i>	
<i>Information gathering</i>	
<i>Selection of solution components</i>	
<u>SOCIAL INTELLIGENCE</u>	
New Measures	
<i>Interpersonal perceptiveness</i>	
<i>Social adroitness</i>	
<i>Harmony facilitation</i>	
<i>Behavioral flexibility</i>	

Note. This table lists the measures administered in the original project. Only those measures typed in italics were administered in this replication. In neither the original nor the replication research were standard measures administer for the following categories: knowledge, social judgment skills, problem-solving skills, practical intelligence, and social intelligence.

## Method

### Participants

Data were collected on leaders in the chains of command of 53 battalions across eight Army posts. The research plan called for administration of the problem-solving predictors to the following per battalion: the battalion commander (BNC), 4 company commanders (CCs), and 16 platoon leaders (PLs). The planned sample also included superiors and subordinates of the chain-of-command officers: the brigade commander (BGDC) of each BNC, 4 battalion staff officers (BSs) under the BNC, and 10 platoon members serving under each PL sampled.

The obtained sample of chain-of-command leaders consisted of 53 BNCs, 227 CCs, and 490 lieutenants in PL or other entry positions. A total of 3843 platoon members across 469 platoons and 144 BSs across 47 battalions rated the transformational leadership of their superiors (PLs and BNCs, respectively). BGDCs provided superior ratings of 35 BNCs.

Table 2 describes the returns for the measures targeted on the chain-of-command leaders. Officers reported demographic data

Table 2.

Distribution of Obtained Chain-of-Command Leaders by Rank and Type of Measure

Rank	Predictors			Criteria	
	Back-ground Data	Demo- graphics Form	Problem- Solving Exercises	Superior Ratings	Subordinate Ratings
01/02	312	322	319	409	333
03	162	166	166	196	192
05	41	41	36	35	50

Note. The numbers of 01/02s, 03s, and 05s with data on all types of measures (listwise complete) were, respectively, 169, 199, and 22.

on a separate demographic form or on the form used to rate their superior leader. Of the 607 chain-of-command officers reporting gender, only 13 were female. Mean tenure in the Army ranged from 25.7 months for second lieutenants to 224.5 months for BNCs. Tenure in present battalion was 7.7 months for second lieutenants, 14.4 months for first lieutenants, 11.8 months for captains, and 11.9 months for lieutenant colonels. The predominate commissioning source was the Reserved Officer Training Corps (n = 342), followed by the U.S. Military Academy (n = 139) and Officer Candidate School (n = 52).

## Measures

### Predictors

The chain-of-command leaders provided demographic data and responded to instruments that measured the cognitive and temperament variables set forth as predictors of leader problem-solving effectiveness. One instrument measured general cognitive abilities.<sup>1</sup> Three instruments measured complex problem-solving skills. The third instrument contained background-data measures which were developed for the original investigation and which were intended to measure personality, motivational, and a variety of cognitive variables.

Demographic description The chain-of-command officers completed a demographic form which provided spaces for entering their present officer grade (or rank), present unit and position, number of months on active duty in the Army, number of months in their current position, and other background data. This form also contained the items, described later, used to count the awards received during their career.

Problem-solving predictors General cognitive ability was assessed by a 12-item version of a standardized measure of verbal reasoning, the Employee Aptitude Survey (EAS) Verbal Reasoning Test. This version was reported in the original validation as having reliability in the .70s (cf. Mumford et al., 1993). As in the original validation, an individual's responses were scored by counting the number of correct responses and by translating the obtained raw score into a score on a standard distribution. The transformation produced scores ranging from 0 to 45.

Responses to open-ended problem-solving exercises were used to assess three sets of complex problem-solving skills: problem construction, social judgment, and component problem-solving skills. Each exercise, one for each set of skills, consisted of one or two scenarios. Each exercise required respondents to read a scenario and then give written responses to questions posed about the situation described in the scenario. The scenarios and questions in each exercise had been constructed for the original investigation. An exercise was intended to elicit responses which could be scored for dimensions or elements of the complex skills targeted by the exercise. Exercise completion was timed

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<sup>1</sup> Both the original construct validation and this replication included a second measure of general ability. This was a standardized measure of spatial ability. Results on spatial ability were not reported in the most recent presentation of the original validation. Following the original format, the present report also excluded results on spatial ability.

so that officers were allowed 10 minutes to respond to the one or two scenarios in an exercise.

Responses to the exercises were rated per scenario. Table 3 lists the variables, by problem-solving skill, used to rate the scenarios. The variables in Table 3 are the dimensions (or elements) which, by the model under investigation, formed or otherwise characterized the skills. Rating involved reading the responses given to a scenario and (depending on the exercise and the variable) using a 5-point or 6-point scale to assign a value

Table 3  
Dimensions Used to Rate Problem-Solving Exercises

Exercise	Cognitive Skills Measured	Dimensions Rated
Military Scenarios	Problem Construction	<ul style="list-style-type: none"> <li>-Short vs long term implications</li> <li>-Attention to restrictions</li> <li>-Self oriented goals</li> <li>-Organizationally oriented goals</li> <li>-Quality</li> <li>-Objectivity</li> <li>-Number of alternatives</li> <li>-Originality</li> </ul>
Organizational Scenarios	Social Judgment Skills	<ul style="list-style-type: none"> <li>-Self objectivity</li> <li>-Self reflectivity</li> <li>-Sensitivity to fit</li> <li>-Systems perspective</li> <li>-Good judgment under conditions of uncertainty</li> <li>-Systems commitment</li> <li>-Overall wisdom</li> </ul>
Problem Solving Processes	Problem-Solving Component Skills	<ul style="list-style-type: none"> <li>-Problem construction</li> <li>-Information encoding</li> <li>-Category search</li> <li>-Specification of best fitting categories</li> <li>-Combination and reorganization</li> <li>-Idea evaluation</li> <li>-Implementation</li> <li>-Monitoring</li> <li>-Overall quality</li> <li>-Overall originality</li> </ul>

indicating the extent to which (or how well) the dimension was represented in the responses.

The open-ended responses were rated by individuals who were trained by others having served as raters in the original investigation. Training involved discussion of the variables used to rate the scenarios, practice in making ratings, and further discussion of similarities and differences in the ratings made. The overall aim of the training was to develop common meaning and application of dimensions in terms of the scenarios contained in the exercises.

A total of six different individuals rated responses to the exercises. Responses were assigned so that each officer's response to each exercise was evaluated independently by three trained raters. Table 4 describes the raters who scored some proportion of the responses to the three exercises. As Table 4 shows, four individuals served as raters for two exercises. The other two individuals scored some proportion of the responses to either only one exercise or to all three.

Table 4.  
Distribution of Raters by Problem-Solving Exercise

<u>Rater</u>	<u>Exercise</u>		
	<u>Problem Construction</u>	<u>Social Judgment Skills</u>	<u>Problem Solving Process</u>
A	+	+	+
B	+	-	+
C	-	+	+
D	+	+	-
E	+	+	-
F	+	-	-

Note. Entries indicate whether an individual rater did (+) or did not (-) score an exercise.

Background data inventory. The background data inventory (BDI) contained questions about certain life events and experiences and about one's behavior and feeling in past situations. Respondents answered by choosing, from the alternatives given, the particular alternative that best described the extent to which the experience had typically applied to them personally. The BDI had been constructed for the original investigation to measure variables in the domains of personality, motivation, and cognition (to include general cognitive skills, practical intelligence, social intelligence, and social judgment skills).

A reduced version of the original BDI was used in this replication. The reduction was based on results of factor analyses of the BDI data collected in the original investigation. More specifically, for each domain which the BDI had been designed to measure, a separate factor analysis was conducted on responses to the items which were expected to measure the variables in the domain. For example, responses to the items expected to measure the four variables in the domain of social intelligence (interpersonal perceptiveness, social adroitness, harmony facilitation, and behavioral flexibility) were included in a separate factor analysis. The 175 items with strongest loadings on the expected variables (in general, the top 6 items with eigen values of .30 or greater for each factor obtained) formed the BDI for this replication.

### Criteria

Career Achievement. Two indicators of career achievement served as criteria: self-reported rank and awards. Officers reported their grade on the demographic form. On this same form, officers also checked whether they had ever during their career received each of the medals on the following list: Army Good Conduct Medal, Meritorious Service Medal, Defense Meritorious Service Medal, Army Commendation Medal, Letter of Commendation, Army Achievement Medal, Silver Star, Bronze Star, Air Medal, Purple Hear, Medal of Honor, Legion of Merit, Campaign Medal, Other. This list was among the set of verifiable indicators of leader achievement developed for the original validation. For the present research, awards received was measured as the total count of medals checked on this list.

Leadership Performance. Leadership performance was evaluated by both a leader's superior officer and his or her subordinates. For superior evaluations, chain-of-command leaders assessed the "competence" of their subordinate leaders "to engage in" types of military missions. The rating form contained a table of missions by target leader rated. The eight missions, presented as the table rows, were based on missions that the Army



could be called upon to perform, as described in the U.S. Army Field Manual 100-5 Operations (1993). These mission types were: mid intensity attack, mid intensity defense, low intensity attack, low intensity defense, noncombatant evacuation, humanitarian assistance & disaster relief, support to counter drug operations, and combating terrorism. The columns of the table contained spaces in which a leader entered the subordinates to be evaluated. CCs entered designations for and evaluated their PLs. BNCs designated and evaluated CCs and PLs in their commands. BNCs used one form to evaluate all CCs and separate forms to rate PLs in each company. BGDCs evaluated their subordinate BCs. To complete the table, superior officers assessed each subordinate's competence for performing each mission on a five-level scale anchored (and scored) as: fair (1), good (2), very good (3), excellent (4), and best of all (5). Leaders were instructed to use the following as a comparison in assessing a subordinate leader: "all other officers you have known of about the same age, rank, and command position". A superior's evaluation of a subordinate leader was computed as the average of the superior's assessments across missions for the subordinate.

Subordinate ratings on the Multifactor Leadership Questionnaire (Bass & Avolio, 1991) were used to assess the transformational leadership behaviors of their immediately superior officer. The forty-seven items for the five dimensions of transformational leadership were averaged to form a single scale. Scale reliability was high for each type of subordinate rater (a coefficient  $\alpha$  of .97 or greater). The ratings of like subordinates (for example, platoon members) of a particular leader (for example, PL) were aggregated to form a single score for each target leader and for each type of subordinate rater.

Properties of Criteria. Table 5 shows correlations among the four criteria. Rank and awards were strongly correlated. Rank and awards were also positively and significantly correlated with the leadership performance assessments, with this relationship moderately strong for subordinate assessments. The correlation between superior and subordinate ratings of leadership performance was significant but weak.

Correlations between raters were computed for leaders assessed by more than one rating group. The evaluations of PL leadership by BNCs and CCs were weakly correlated ( $r = .26$ ,  $p < .05$ ,  $n = 332$ ), and partialing PLs' time in the battalion somewhat strengthened this relationship ( $r = .35$ ,  $p < .05$ ,  $n = 203$ ). BSs' and CCs' assessments of BNCs' transformational leadership yielded moderately strong correlations ( $r = .41$ ,  $p < .05$ ,  $n = 44$ ), and this moderately strong relationship was not changed substantially

after having controlled for the BC's time in the battalion ( $\underline{r} = .43$ ,  $p < .05$ ,  $n = 28$ ).

Table 5.  
Means, Standard Deviations, and Correlations between Criteria

	<u>Mean</u>	<u>Standard Deviation</u>	<u>Correlations</u>		
			<u>1</u>	<u>2</u>	<u>3</u>
1) Rank	2.20	1.20	—		
2) Awards	2.25	1.87	.70*	—	
3) Subordinate Evaluations	3.28	.63	.50*	.41*	—
4) Superior Ratings	3.20	.88	.23*	.13*	.11*

\*  $p < .05$ .

### Procedures

About one month prior to on-site data collection at a post, envelopes containing demographic information forms and background data surveys were sent for distribution to each chain-of-command leader designated for research participation. The packets included instructions explaining the purpose of the research. The packets also instructed officers to complete the enclosed materials at their convenience and to take the completed materials to an in-class session scheduled for their battalion.

A two-hour, in-class session was scheduled for the chain-of-command leaders in each battalion. In the in-class session, the officers completed the two cognitive measures and the three open-ended problem-solving exercises. The CCs and PLs then responded to the MLQ to rate the leadership behavior of their immediate superior in the chain-of-command. While CCs and PLs responded to the MLQ, the BNC provided superior evaluations of the leadership of the CCs and PLs within their battalion. After responding to the MLQ, each CC completed superior evaluations of the leadership of each PL in their company.

A separate in-class session was held for the PMs and BSs in each battalion. After instructions on the purpose of the research, PMs and BSs responded to the MLQ to rate, respectively, the leadership behavior of their PL and BNC.

Office appointments were scheduled with BGDCs. During the office calls, the purposes of the research and of the superior evaluations were explained. BGDCs also received the form for evaluating the leadership of the subordinate BNCs with battalions included in the research. Depending on a BGDC's availability, the BGDC either completed the form during the office call or kept the form for later completion and return.

## Results

### Properties of the Measures

Table 6 groups the predictor variables by type of measure (background data inventory (BDI) or problem-solving exercise) and displays the obtained descriptive statistics.

#### BDI Scales

As described earlier, the BDI scales used in this replication contained a smaller number of items than the version used originally. Factor analyses (principal components analyses with oblimin rotations) were conducted to examine the stability of the expected BDI scales. A separate factor analysis was conducted for responses to the retained items in each domain (e.g., the retained motivation items). One exception was that the cognitive and practical intelligence items were factor analyzed together because of the apparent similarity of the items in these two dimensions; the sample size also permitted a combined analysis (i.e., a greater than 10 to 1 ratio). From these analyses, scales were formed to represent the obtained factors. Scales were formed by averaging the responses to items which had rotated factor loadings of .30 or greater and which had been used in the original research to form a scale (or in the case of the BDI scale of "problem solving", the items which formed the original scales captured by the problem-solving factor obtained in this replication).

Table 6 describes the number of items and reliability of each scale. The replicated scales and the lengths of those scales differed from some of the original scales due to: a) differences in the results of the factor analysis and b) adjustments by the original researchers to the procedures for combining items prior to their more recent presentation but after items had been selected for this replication. The reliabilities of the obtained scales compared favorably with the reliabilities reported for the original BDI scales.

Table 7 shows correlations between the BDI scale scores obtained in this replication. It is not clear that given the

Table 6.  
Descriptive Statistics for Measures of Predictor Variables

<u>Measure</u>	<u>Mean</u>	<u>Standard Deviation</u>	<u>Reliability<sup>1</sup> (No. Items)</u>
<u>BDI Scales</u>			
Cognitive--			
Reading orientation	2.66	.88	.65 (2)
Motivation--			
Social recognition	2.97	.62	.78 (7)
Social commitment	2.38	.92	.73 (2)
Affiliation need	3.59	.55	.53 (5)
Social alienation	2.60	.56	.66 (6)
Personality--			
Self discipline	3.61	.51	.88 (8)
Rigidity	3.34	.71	.46 (2)
Locus of control	3.81	.57	.59 (4)
Practical Intelligence--			
Planning under ambiguity	3.41	.47	.70 (10)
Information gathering	3.39	.65	.66 (6)
Problem solving	3.61	.45	.82 (12)
Social Intelligence--			
Interpersonal perceptiveness	3.73	.52	.84 (8)
Social adroitness	3.34	.65	.79 (2)
Harmony facilitation	3.61	.52	.65 (6)
Behavioral flexibility	3.28	.51	.50 (5)
Social Judgment--			
Insightfulness	3.36	.71	.48 (2)
Self reflectivity	3.16	.61	.74 (6)
Good judgment	3.70	.56	.61 (3)
Systems perceptiveness	3.44	.54	.54 (4)
<u>Problem-Solving Exercises<sup>2</sup></u>			
Verbal Reasoning	27.79	7.21	N/A
Problem construction	2.56	.43	.79
Social Judgment	2.89	.52	.75
Component Skills	2.66	.50	.79

Note. See Table 2 for approximate numbers of leaders completing the BDI and the problem-solving exercises  
<sup>1</sup> Reliabilities measured by the coefficient  $\alpha$  and for the BDI scales (number of items per scale in parentheses)  
and by the intraclass correlation for the problem-solving exercises.  
<sup>2</sup> Verbal Reasoning was measured by a multiple-choice test. The other exercises produced open-ended responses.

Table 7.  
Correlations between BDI Scales

BDI Scale	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Cognitive																			
1) Reading orientation	--	.11	.02	.02	.18	-.09	.23	.13	-.12	.31	.19	.09	.18	.08	.18	.13	.19	-.12	.18
Motivation																			
2) Social recognition	--	--	.00	.03	.32	-.24	.03	.28	-.35	.17	.17	.09	.05	-.24	.08	-.14	-.01	-.13	.09
3) Social commitment			--	.13	.09	-.17	.09	-.14	-.22	.17	.20	.10	-.10	.17	.17	.25	.08	-.21	.11
4) Affiliation need				--	-.22	.29	.16	.05	.18	.25	.36	.29	.20	.38	.37	.32	.00	.21	.26
5) Social alienation					--	-.69	.12	.28	-.53	.14	.04	.00	-.50	-.08	-.05	.03	.33	-.53	.12
Personality																			
6) Self discipline						--	-.02	-.14	.65	.04	.12	.12	.51	.14	.17	.05	-.28	.65	-.02
7) Rigidity							--	.15	.06	.24	.43	.26	-.06	.19	.36	.25	.06	-.04	.32
8) Locus of control								--	-.15	.16	.23	.22	-.15	.07	.02	.00	.30	-.01	.26
Practical Intelligence																			
9) Planning under ambiguity									--	.02	.20	.21	.46	-.01	.22	.02	.51	.57	.08
10) Information gathering										--	.46	.32	.01	.35	.31	.33	.23	-.04	.40
11) Problem solving											--	.52	.07	.47	.53	.47	.04	.11	.55
Social Intelligence																			
12) Interpersonal perceptiveness												--	.11	.44	.40	.44	.06	.12	.49
13) Social adroitness													--	.13	.07	.04	-.28	.50	.03
14) Harmony facilitation														--	.42	.44	.18	.13	.35
15) Behavioral flexibility															--	.32	-.03	.09	.35
Social Judgment																			
16) Insightfulness																--	.07	-.07	.33
17) Self reflectivity																	--	-.25	.09
18) Good judgment																		--	.01
19) Systems perceptiveness																			--

Note. With an approximate sample size of 515, all correlations of  $\pm .09$  were statistically significant ( $p < .05$ ). Also statistically significant ( $p < .05$ ) were the two .08 correlations between reading orientation and harmony facilitation and between social recognition and behavioral flexibility were .

domains covered by the BDI, one would necessarily expect that the correlations between the variables within the same domain would be stronger than the correlations between the variables in different domains. To the extent such an expectation makes sense, however, the correlations in Table 7 tend to question the divergence of the measures yielded by the BDI, if not the model underlying it. For example, the BDI was constructed to measure components of both social intelligence and social judgment. If these are indeed separate constructs, it seems reasonable to expect a pattern of relatively stronger correlations between the components within a construct than across constructs. Such a pattern was not clearly obtained. Examination revealed that the range of the absolute values of the correlations between components of social intelligence was .07 - .44, with a median of about .26. For social judgment, the range and median for absolute values were .01 - .33 and .08, respectively. These within-domain statistics were hardly distinguishable from the comparable statistics for the absolute values of the across-domain correlations. The across-domain range was .03 - .50, and the cross-domain median was .20.

#### Measures Derived from Problem-Solving Exercises

The final score for each of three problem-solving exercises was derived according to the procedures in the most recent presentation of the original research. For each of the exercises, this score was computed by averaging (across scenarios) the scores assigned to each dimension by the three raters for an exercise. These dimension averages were then again averaged to yield a total score for the exercise. It should be noted that raters had been instructed not to score responses to a scenario (or to a particular question) when the responses were too incomplete to make judgments on the scoring dimensions. Due to these instructions, scores for some respondents were based on ratings for a reduced number of dimensions, and the scores were not adjusted for the completeness of a response.

The reliability of ratings of the open-ended problems-solving exercises was assessed by the procedures used in the more recent presentation of the original research: intraclass correlations (Shrout & Fleiss, 1979) of the total exercise scores. By these procedures, reliability was assessed at the level of the overall construct measured by an exercise and at the level of the aggregation which produced the overall measure. The intraclass correlations obtained for the three open-ended measures ranged from .71 to .81. This range was comparable to that reported in the original research (i.e., .67 to .82).

Table 8 presents correlation between the three scores derived from the open-ended exercises. Table 8 also includes the correlations with the other cognitive predictors, verbal reasoning and the BDI scale of reading orientation. Table 8 shows that the significant correlations between the three open-ended measures were positive but moderately strong at best.

Table 8.  
Correlations between Cognitive Measures

Measure	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
1) Problem construction	--	.36*	.30*	.07	.05
2 Social judgment		--	.34*	.13*	.04
3) Component skills			--	.19*	.15*
4) Verbal reasoning				--	.18*
5) Reading orientation					--

\*  $p < .05$ .

Two of the open-ended exercises were significantly correlated with verbal reasoning were not statistically significant. The BDI "reading orientation" scale was positively and significantly correlated with only one of the three open-ended measures (component problem-solving skills) and with verbal reasoning. The correlations with verbal reasoning and reading orientation were no greater than .19 and, thus, relatively weak.

The data in Table 8 suggested greater consistency within measurement method. As a further examination, each dimension rating for each of the five scenarios in the open-ended exercises (two scenarios for problem construction, two for social judgment, and one for component problem-solving skills) was treated as a score. This score was computed (per respondent) as the average of the ratings which the three raters had assigned to the dimension and for the scenario. These scores were then entered into a factor analysis (principal components, oblimin rotation). Six factors emerged, with the factors tending to represent the scenario to which the rating had been assigned. More specifically, one factor emerged for each of the four scenarios comprising the social judgment and the problem construction exercises. Two additional factors reflected the first and second half of the measure of component problem-solving skills.

Results of the factor analysis are perhaps reflected in Table 9 which contains correlations between the scores on each scenario. Based on these correlations, it appears that the scores for scenarios in the same exercise were relatively more strongly correlated than were the scores for scenarios in different exercises. However, the correlations within exercises were at best moderately strong (range of .41 to .43). Together

Table 9.  
Correlations between Ratings of Separate Scenarios in Problem-Solving Exercises

Exercise	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>5</u>
1) Problem Construction Scenario 1	---	.43	.19	.26	.23
2) Problem Construction Scenario 2		---	.24	.31	.26
3) Social Judgment Scenario 1			---	.41	.25
4) Social Judgment Scenario 2				---	.31
5) Component Skills (One Scenario)					---

Note. All correlations statistically significant ( $p < .05$ ). Sample per correlation varied from 537 to 584 leaders.

with results of the factor analyses, these correlations tend to question the measures, that is, whether the constructs intended for measurement or some other property of the exercises drove the open-ended responses.

#### Relationships between BDI and Open-Ended Predictors

Within the validation framework, the BDI scales representing cognitive ability, practical intelligence, and social intelligence were expected to predict officers' social problem-solving skills and career Army achievement. As such, it is appropriate to examine correlations between the BDI scales and the cognitive and problem-solving skills measured by the open-ended exercises. As contained in Table A-1, Appendix A, the BDI scale of "problem solving" was significantly correlated with two



of the problem-solving exercises. However, these correlations were relatively weak (at best, .20), and consistent relationships were not obtained for any of the other BDI scales related to cognitive ability, intelligence (social or practical), and social judgment.

### Test of the Problem-Solving Model/Measures

Two sets of analyses were conducted to test relationships among predictors and criteria. First the raw correlations between the predictor and criterion sets were computed and compared with those reported originally. Second, regression analyses were conducted to test the significance of the parsimonious model, derived in the original research, with the expanded criteria collected as part of this replication.

### Correlations between Predictors and Criteria

Table 10 presents the correlations between predictors and criteria obtained in this replication. Table 10 includes the 22 measures which were common to the two data collections. It also contains correlations for the BDI scale of problem solving derived in this replication. The problem-solving scale was computed from items which, in the original effort, had been used to form five separate scales.

Similarities between the original and replication correlations were evident for the measures of career achievement. Of the 22 common predictors, 21 were significantly associated with career achievement in the original data collection. Of those 21 predictors, 12 in this replication were significantly correlated with rank, self-reported awards, or both. The BDI scale of problem solving was significantly correlated with both rank and self-reported rewards; the original effort found that three of the scales with items contributing to problem solving were significantly correlated with the career achievement. Despite the correspondence of results for career achievement criteria, the correlations obtained in this replication tended to be weaker than those obtained originally. This attenuation was especially noticeable for the measures of problem-solving skills derived from the open-ended exercises.

In sharp contrast to the correlations with rank and awards, few predictors were significantly associated with superior and subordinate assessments of leadership performance. Of the 46 correlations, only five were statistically significant and in the expected direction (social alienation, planning under ambiguity, problem solving, systems perceptiveness, and problem

Table 10.  
Correlations between Predictors and Criteria

<u>Predictors</u>	<u>Achievement</u>		<u>Leadership Performance</u>	
	<u>Rank</u>	<u>Awards</u>	<u>Superior Ratings</u>	<u>Follower Ratings</u>
<u>BDI Scales</u>				
Cognitive--				
Reading orientation	-.06	-.23	.00	-.07
Motivation--				
Social recognition	-.05	-.02	.07	.08
Social commitment	-.02	.02	-.10	-.04
Affiliation need	-.03	.01	.01	-.04
Social alienation	-.16	-.17	-.03	-.12
Personality--				
Self discipline	.09	.11	.06	.02
Rigidity	-.01	.01	.06	-.04
Locus of Control	.09	.04	.04	-.02
Practical Intelligence--				
Planning under ambiguity	.17	.16	.09	.11
Information gathering	.01	.00	.07	-.07
Problem solving	.20	.20	.13	.06
Social Intelligence--				
Interpersonal perceptiveness	.10	.13	.08	.04
Social adroitness	.06	.09	.02	.04
Harmony facilitation	.08	.07	-.01	.04
Behavioral flexibility	.08	.13	.07	.01
Social Judgment--				
Insightfulness	-.05	-.04	.02	-.03
Self reflectivity	-.20	-.15	.00	-.12
Good judgment	.23	.23	.04	.09
Systems perceptiveness	.16	.17	.18	.01
<u>Problem-Solving Exercises</u>				
Verbal Reasoning	-.02	-.05	.06	-.01
Problem construction	.24	.26	.07	.11
Social Judgment	.18	.19	.07	.07
Component Skills	.08	.05	.07	.07

Note. For awards, correlations of .09 or greater were statistically significant ( $p < .05$ ). For other criteria, correlations of .10 or greater reached significance.

construction). Another two correlations (social commitment and self reflectivity) were statistically significant but not in the expected direction.

Correlations of predictors with leadership ratings within levels of the chain of command are presented in Table A-2, Appendix A. Because officers at the same level were of similar rank, these analyses provided a control for the effects of rank. Of the 184 correlations in Table A-2, only 16 were statistically significant, and no consistent pattern was discernible.

### Regression Analyses

In the original effort, a series of regression analyses were conducted to identify the predictor sets which reduced the number of possible predictors while maximally accounting for career achievement. Due to variations in the open-ended problem-solving exercises completed by officers in the original effort, two general sets of models were actually derived. One set applied to the portion of the original sample which had taken the exercise measuring "problem construction". The other set was based on the respondents who had completed the exercise measuring "social judgment". Simultaneous regression analysis showed that the models accounted for up to 36% of the variance in career achievement.

The original models with the measure of "problem construction" were chosen for repeated testing. These models were chosen because their predictors mapped more readily onto the measures collected in this replication. Their use also reduced the risks of prematurely rejecting the original findings in that the original models with problem construction had been relatively stronger than the original model with social judgment. Minimizing those risks seemed justified given the attenuated correlations found in this replication.

To test the models, the variables which most closely approximated those in the original models were identified. This resulted in selection of the following variables for inclusion in the model: the measures of problem-solving component processes and problem-construction based on the open-ended exercises and the BDI scales measuring planning under ambiguity, reading orientation, rigidity, interpersonal perceptiveness, and problem-solving. The BDI problem-solving scale included items on several of the separate BDI scales included in the original models.

Table 11 summarizes results of the regression analyses conducted in this replication. The predictor set significantly predicted all measures of career achievement and leadership

Table 11.  
Results of Predictor Model

<u>Predictor</u>	<u>Achievement</u>		<u>Leadership</u>	
	<u>Rank</u>	<u>Awards</u>	<u>Performance Ratings</u>	<u>Superior</u> <u>Follower</u>
<u>BDI Scales</u>				
Reading orientation	-.07	-.03	-.03	-.08
Rigidity	-.11*	-.09*	.00	-.05
Planning under ambiguity	.18*	.18*	.07	.13*
Interpersonal perceptiveness	-.06	-.03	-.04	-.01
Systems perceptiveness	.17*	.18*	.17*	.02
Problem solving	.08	.06	.02	.04
<u>Problem-Solving Exercises</u>				
Problem construction	.24*	.26*	.06	.09
Component skills	-.02	-.01	.06	.08
<u>R<sup>2</sup></u>	<u>.14*</u>	<u>.14*</u>	<u>.04*</u>	<u>.04*</u>
(n)	(443)	(417)	(338)	(451)

Note. Except as otherwise indicated, entries are standardized  $\beta$  weights.

\* $p < .05$

performance. While statistically significant, the contributed variances was at best 14%, and the level of contribution appeared to be consistently greater for the criterion measures of career achievement (14%) than for the measures of leadership performance (4%). Moreover, the obtained levels of prediction were substantially smaller than the originally reported estimates of 32% to 36% for the similar predictor sets. Of the 184 correlations in Table A2, only 16 were statistically significant, only seven more than expected by chance. Of those 16, five were in the unexpected direction.

### Discussion

Results of this replication provided some support for the hypothesis that the cognitive and temperament variables set forth in the problem-solving model of leadership explain variance in the leadership of officers. The variables were significantly

correlated with the achievement measures of rank and awards, and the prediction equations for the achievement measures were significant. Despite these, all relationships with achievement were smaller in magnitude than had been obtained originally. Moreover, the original findings were not replicated for the more direct measures of leadership, the assessments made by subordinates and superiors. The separate variables were not consistently related to subordinate or superior assessments, and relationships of the predictors as a group to such assessments were weak.

Several limitations of this field test possibly contributed to the lack of consistent relationships with the measures of leadership performance. First, the relatively junior status of the replication sample (predominately lieutenants and captains) may have attenuated relationships. That is, a premise of the model is that problem-solving requirements are somewhat greater for more senior leaders. Given this premise, the model is possibly most descriptive of senior leaders, and stronger relationships would have possibly been obtained if the sample had consisted of more senior leaders. Second, the method for measuring superior evaluations in this replication was possibly weak. Weakness was suggested by the low convergence of the superior evaluations with the other criteria. In particular, the correlations between rank, awards, and subordinate ratings were as expected: moderately high (those involving subordinate ratings) to high (between rank and awards). In contrast, the correlations of these criterion measures with superior evaluations were uniformly low (even if statistically significant). Weakness in the measurement of superior evaluations could have reduced the sensitivity of this test in that compared to subordinates, superiors can possibly more accurately assess the effectiveness of organizational problem solving. Superiors, for example, are likely better positioned to observe the effects of solutions across organizational boundaries or hierarchies, to include their effects on goals set by higher echelons. Finally, this replication did not measure organizational conditions which could determine the influence leaders' intellectual abilities on organizational problem solving (Fiedler & Garcia, 1987). In this regard, it is noteworthy that with the exception of level of leadership, the problem-solving model does not explicitly treat organizational or other context variables.

While the leadership levels, superior measure, and neglect of context conditions may have contributed to the weaker than expected replication, the measures of the predictors also deserve consideration. As mentioned earlier, most of the predictor measures were new, that is, developed for and introduced in the original effort. Neither the original research nor this

replication included already validated measures for comparison with the new measures. This gap was a mistake in that the results raise questions about the validity of the new measures. Results generally indicated:

--Lack of convergent and divergent validity. Reasonable expectations about similarities and differences in the relationships between variables or variable groups were not strongly represented in the patterns of correlations. For example, the correlations between the BDI measures within the same variable domain were not consistently stronger than were the correlations between variables in different domains. Similarly, the correlations between the scores for the two scenarios in a problem-solving exercise were at best moderately strong. This lack of convergence for the scenario-level scores was also shown in the factor analysis which produced scenario-specific factors. Such factors raise concerns that the open-ended responses or the scoring processes were driven by the scenarios and not by the intended problem-solving constructs.

--Low predictive validity. Few of the BDI scores for cognitive abilities were significantly correlated with the scores derived from the open-ended measures.

--Contradictory relationships. Especially for the BDI scales, it was not uncommon that significant relations showed the unexpected direction. For example, preliminary examination of Table A2 suggested an encouraging trend. That is, despite the small number of significant correlations (16 of 184), practically all (14 of 16) were obtained for ratings given either by or to the battalion commander. However, further inspection showed that most (5 of 8) of the significant correlations with ratings given to battalion commanders were in the unexpected direction.

It is important to recognize that the support from this replication is limited to the general hypothesis that variables set forth in the model account for variance in leadership effectiveness as indicated by career achievement. As such, the support does not extend to the model as fully elaborated. Indeed, this replication and the original presentation did not directly test the full model. Rather, the original research partitioned the sample and used regression analyses to identify and cross-validate the group of variables which best accounted for the variance in the original criterion measures. This replication followed suit and sought to replicate the original effects for the variable group, with a different sample and with expanded criteria. Until the model has been tested with adequately validated predictors, conclusions about the promise of the model would be premature.

Given the findings, applied use of the model and the measures developed to test it would also be premature. As already discussed, the validity of the measures is open to

question, and these validity questions need answers prior to use of the measures in practice. Measurement reliability also needs consideration, especially the reliability of scores derived from the open-ended problem-solving exercises. In both the original presentation and in this replication, the reliability of the open-ended scores was indexed in terms of the consistency with which the scorers had applied the rating scales: consistency among scorers in the values assigned to a particular response relative to the values assigned to other responses. Such an index fails to indicate the similarity of the values which scorers assign to any response. Similarity between scorers in the values assigned to individual responses is critical for the accurate classification of individuals and for decisions based on the classification. Prior to use of the measures in practice, the desired level of similarity needs to be determined, and the extent to which any particular measure meets the desired level needs to be assessed.

Inter-scorer similarity was explored for responses to the scenarios scored for problem construction. Each of three scorers had used five-point scales to rate the scenario responses on eight dimensions of problem construction. With a five-point scale, differences in the values of any rating by any two scorers could have ranged from zero (no disagreement) to four (used opposite ends of the scale). To assess similarity, each of 300 separate ratings was classified according to the maximum difference between the values of any two of the three scorers for the rating. No disagreement was obtained for 30 (10%) of the 300 ratings. For another 136 ratings (45%), the maximum difference was one point on the rating scale. For 100 ratings (33%), at least two of the three scorers differed by two scale points. The maximum difference was three scale points for another 28 ratings (9%), with only one rating showing a maximum difference of 4 scale points. While this index does not directly describe the amount of actual agreement between any two scorers, one can project from it that exact agreement ranged from 32% to at best 45% of the ratings; it also shows agreement within one scale value ranged from 55% to at best 66%.

Research on the problem-solving model is continuing. This research should include a focus on the reliability and validity of the new measures. This could and perhaps should involve some combination of newer data with the older data sets. Such a combination would create opportunities. For example, neither the original sample nor the replication sample was sufficiently large for a factor analysis of the responses to all BDI items. A combination of samples could support a better examination of the properties of the whole instrument. The continuing research could also involve some re-analysis of the replication and original data. If, for example, future research were to sharpen

the coding systems for open-ended problem-solving exercise, the refined systems could be applied to earlier data. Such a re-analysis could be useful in assessing both the effects of the changes and in determining the appropriateness of comparing findings across separate investigations. Such a re-analysis could also increase confidence in conclusions about the scientific and practical merits of the problem-solving model of leadership.



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## APPENDIX A

### Within Rank Correlations

Table A-1.  
Correlations between BDI Scales and Measures Derived from Problem-Solving Exercises

<u>Measure</u>	<u>Problem Construction</u>	<u>Social Judgment</u>	<u>Component Skills</u>
<u>BDI Scales</u>			
Cognitive--			
Reading orientation	.05	.04	.15*
Motivation--			
Social recognition	.05	.05	.06
Social commitment	-.04	-.01	-.07
Affiliation need	.07	.02	-.03
Social alienation	-.03	-.04	.02
Personality--			
Self discipline	.05	.10*	.05
Rigidity	.14*	.15*	.08
Locus of control	.18*	.07	.10*
Practical Intelligence--			
Planning under ambiguity	.07	.10*	-.01
Information gathering	.02	.01	.01
Problem solving	.20*	.16*	.09
Social Intelligence--			
Interpersonal perceptiveness	.06	.06	.01
Social adroitness	.07	.00	-.02
Harmony facilitation	.06	.06	.03
Behavioral flexibility	.07	.09	-.02
Social Judgment--			
Insightfulness	.04	.04	-.03
Self reflectivity	-.02*	-.02	.06
Good judgment	.11	.06	.02
Systems perceptiveness	.03	.05	.04

Note. See Table 2 for approximate numbers of leaders completing the BDI and the problem-solving exercises.

\* $p < .05$

Table A-2.

Correlations between Predictors and Criteria by Level of Leadership

Measure	Superior Ratings				Subordinate Ratings			
	PL	PL by CC	BNC by BNC	BNC by BS	PL by PMS	CC by PLs	BNC by CCs	BNC by BSS
BDI Scale								
Cognitive--								
Reading orientation	-.05	-.05	.09	-.19	-.01	-.08	-.25	-.29
Motivation--								
Social recognition	.11	-.07	.20*	.07	-.11	-.05	.06	.04
Social commitment	-.08	-.06	-.06	-.25	-.03	-.05	.06	.04
Affiliation need	.07	.08	-.04	-.14	-.01	-.04	-.21	-.06
Social alienation	-.10	-.08	.20*	-.20	-.07	-.03	-.20	.17
Personality--								
Self discipline	.12	.14*	-.10	-.15	.02	-.02	.15	.07
Rigidity	.09	.04	.07	-.10	-.04	.00	-.05	.02
Locus of control	.12	-.06	.02	.04	-.19*	.02	-.03	-.26
Practical Intelligence--								
Planning under ambiguity	.08	.14*	-.03	.22	.03	.03	.02	.27
Information gathering	.06	.10	.07	-.05	-.06	-.07	-.09	-.28
Problem solving	.11	.05	.16	-.20	.04	-.03	-.36*	.04
Social Intelligence--								
Interpersonal perceptiveness	.11	-.01	.16*	.08	.06	-.04	-.24	.05
Social adroitness	.03	.09	-.04	.17	.05	.00	.29	.08
Harmony facilitation	-.04	-.06	.06	.22	.11	-.03	-.13	.06
Behavioral flexibility	.06	.05	.11	.08	.00	-.01	-.03	.03
Social Judgment--								
Insightfulness	.04	.04	.00	.03	-.01	.07	-.32	-.12
Self reflectivity	.00	.03	.15	-.26	.00	.06	-.33*	-.24
Good judgment	.07	.04	-.04	.27	.03	-.10	.29	.10
Systems perceptiveness	.17*	.11	.24*	.08	-.04	-.10	-.38*	-.36*
Problem-Solving Exercise <sup>2</sup>								
Verbal Reasoning	-.01	.11	.09	.00	.04	-.03	-.36*	.04
Problem construction	.06	.06	-.01	.13	-.05	-.05	.40*	.41*
Social Judgment	.10	.05	-.02	.34	-.03	.07	.19	.18
Component Skills	.03	.02	.12	.16	.05	.04	.07	.38*

Note. See Table 2 for approximate numbers of leaders completing the BDI and the problem-solving exercises.

<sup>2</sup> Verbal Reasoning was measured by a multiple-choice test. All other problem-solving variables were measured by ratings of open-ended responses to scenarios.

\*  $p < .05$ .